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Lim

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(54) **RECHARGEABLE BATTERY WITH COLLECTOR PLATES HAVING INSULATORS AND CONDUCTORS**

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H01M 2/04	(2006.01)
H01M 2/18	(2006.01)
H01M 2/26	(2006.01)
H01M 10/04	(2006.01)

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(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

A rechargeable battery includes a plurality of electrode assemblies including positive and negative electrodes separated by a separator and a pair of electrode tabs protruding to both sides. A case receives the plurality of electrode assemblies. First and second current collecting plates cover openings formed on both sides of the case. First and second insulation plates are respectively disposed between the plurality of electrode assemblies and the first and second current collecting plates. The pair of electrode tabs at one side of the electrode assemblies pass through a first through hole formed in the first insulation plate and the pair of electrode tables at the other side of the electrode assemblies pass through a second through hole formed in the second insulation plate.

25 Claims, 8 Drawing Sheets

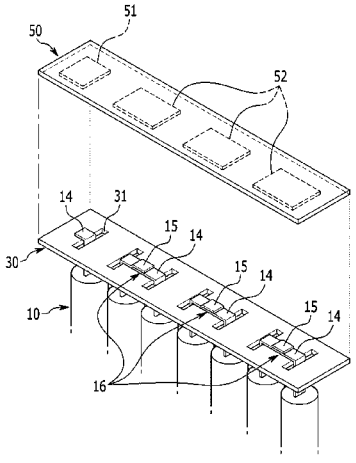

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FIG. 1

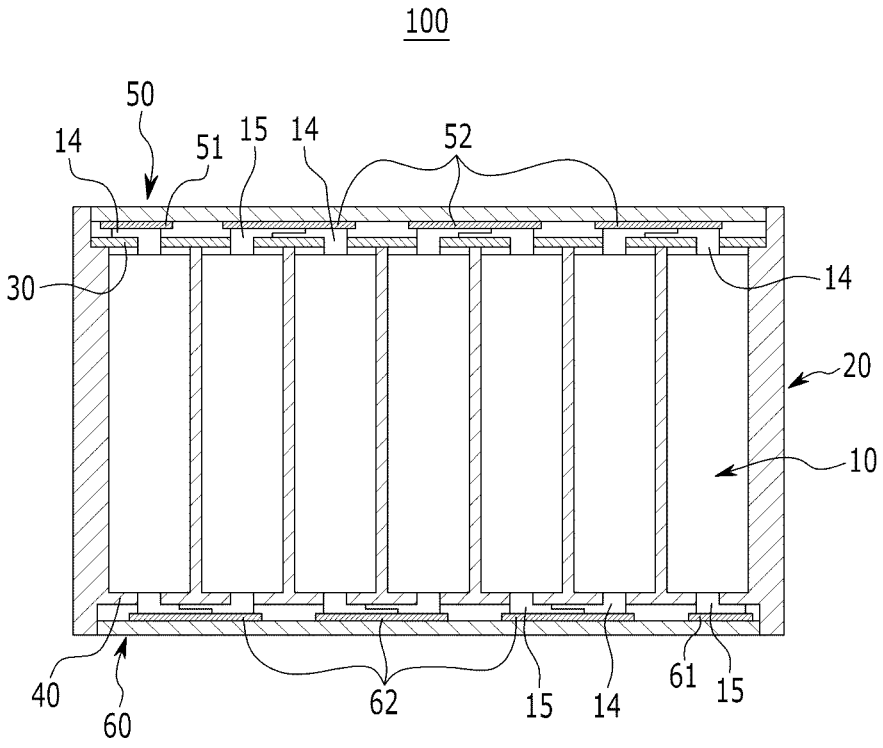

FIG. 2

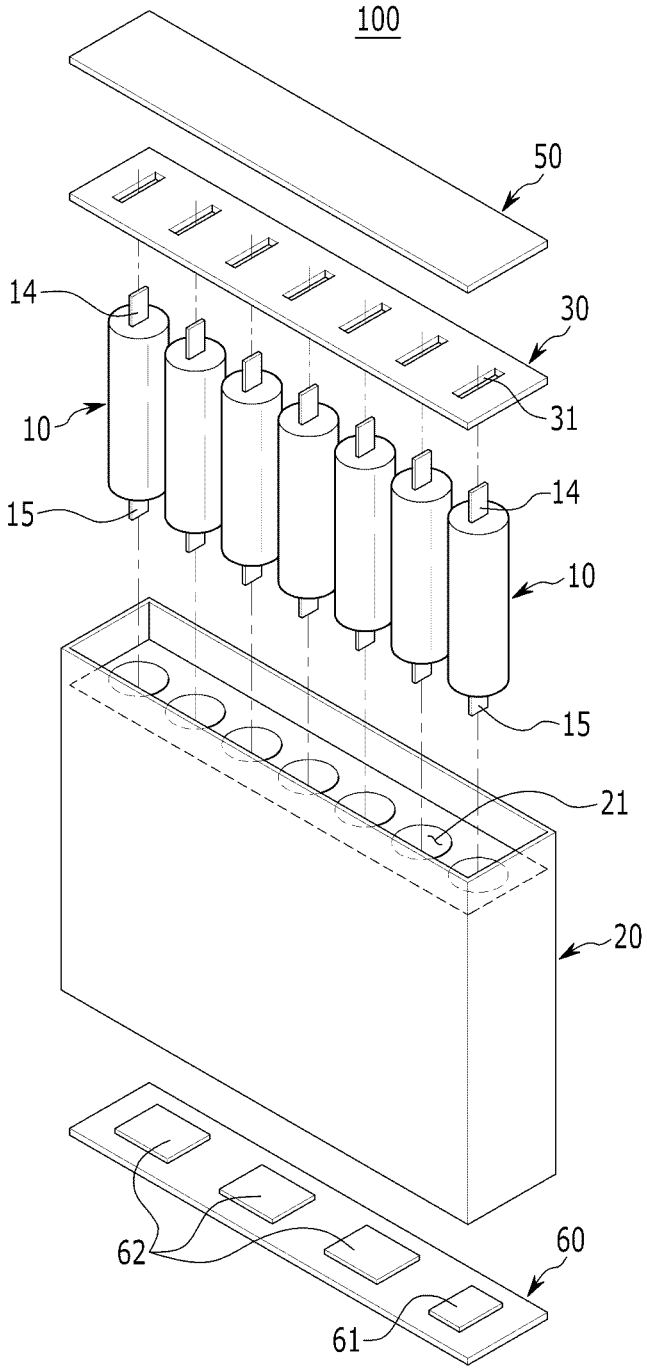

FIG. 3

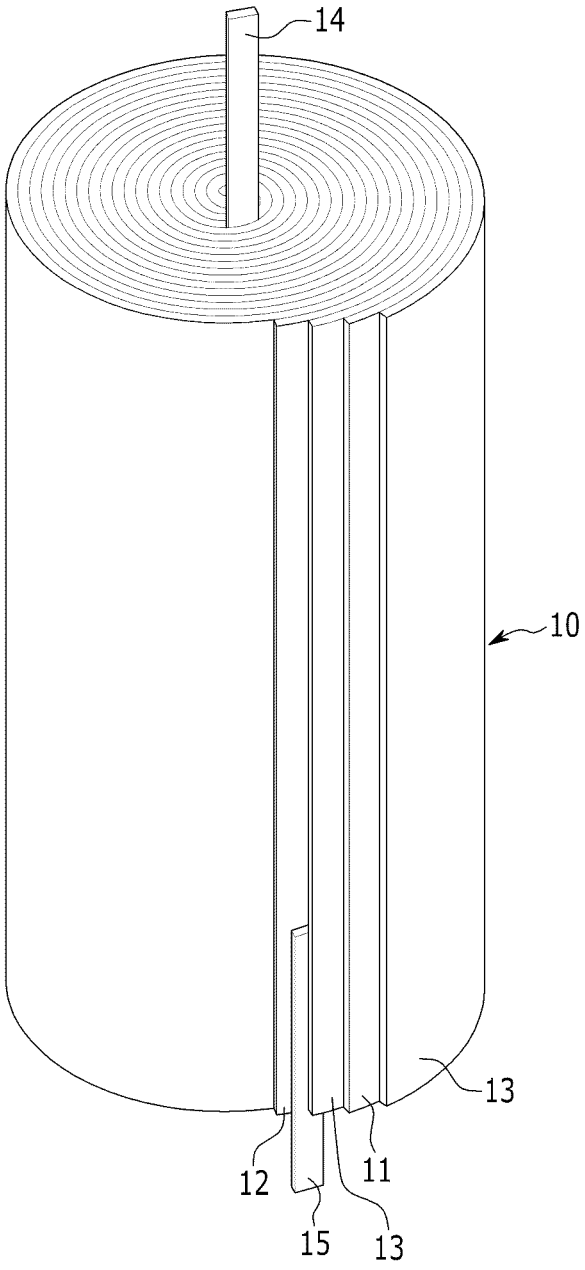

FIG. 4A

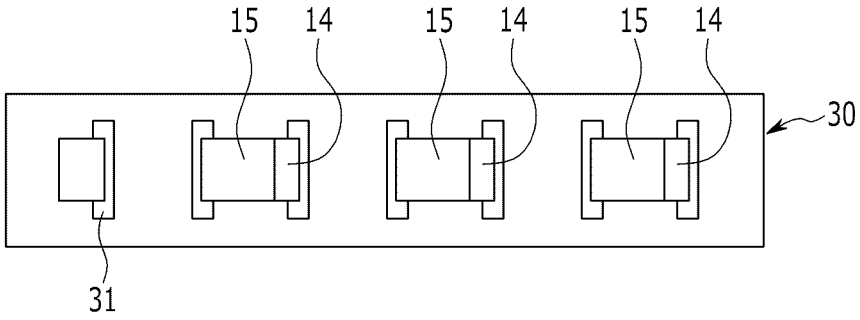

FIG. 4B

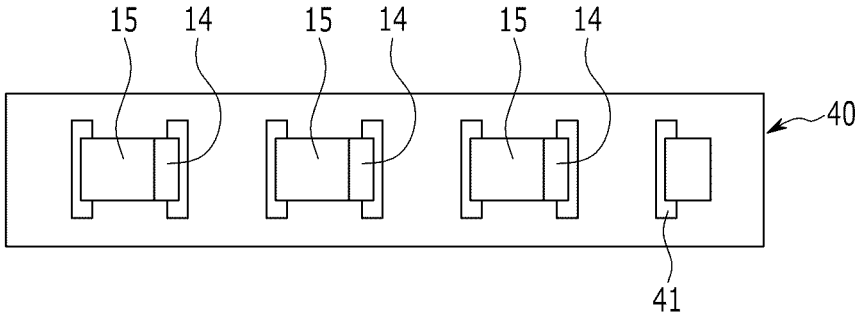

FIG. 5

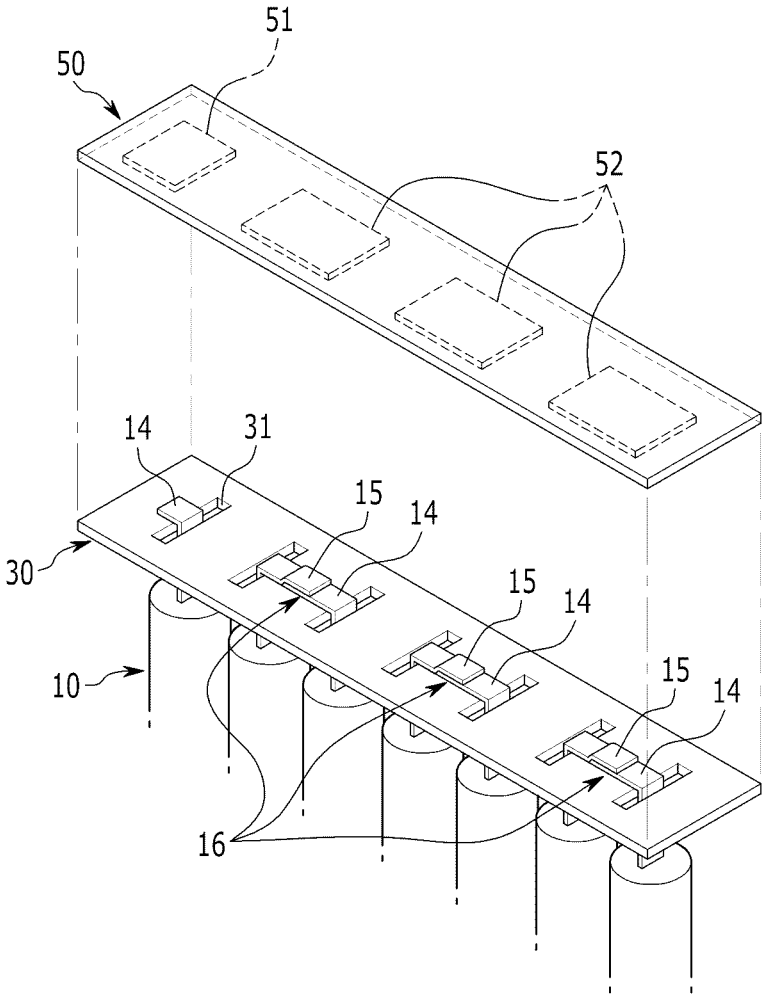

FIG. 6

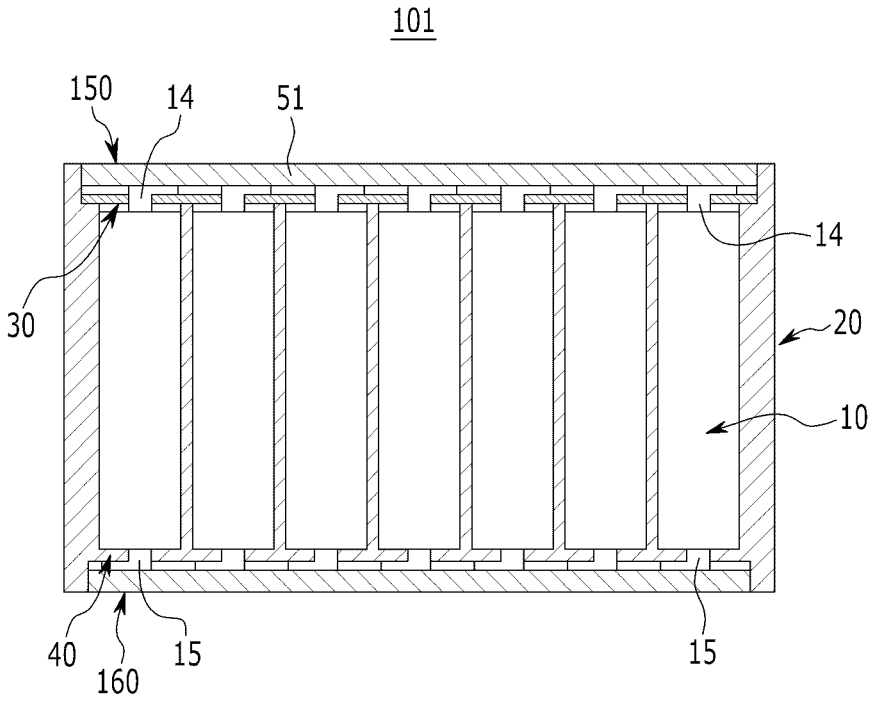

FIG. 7

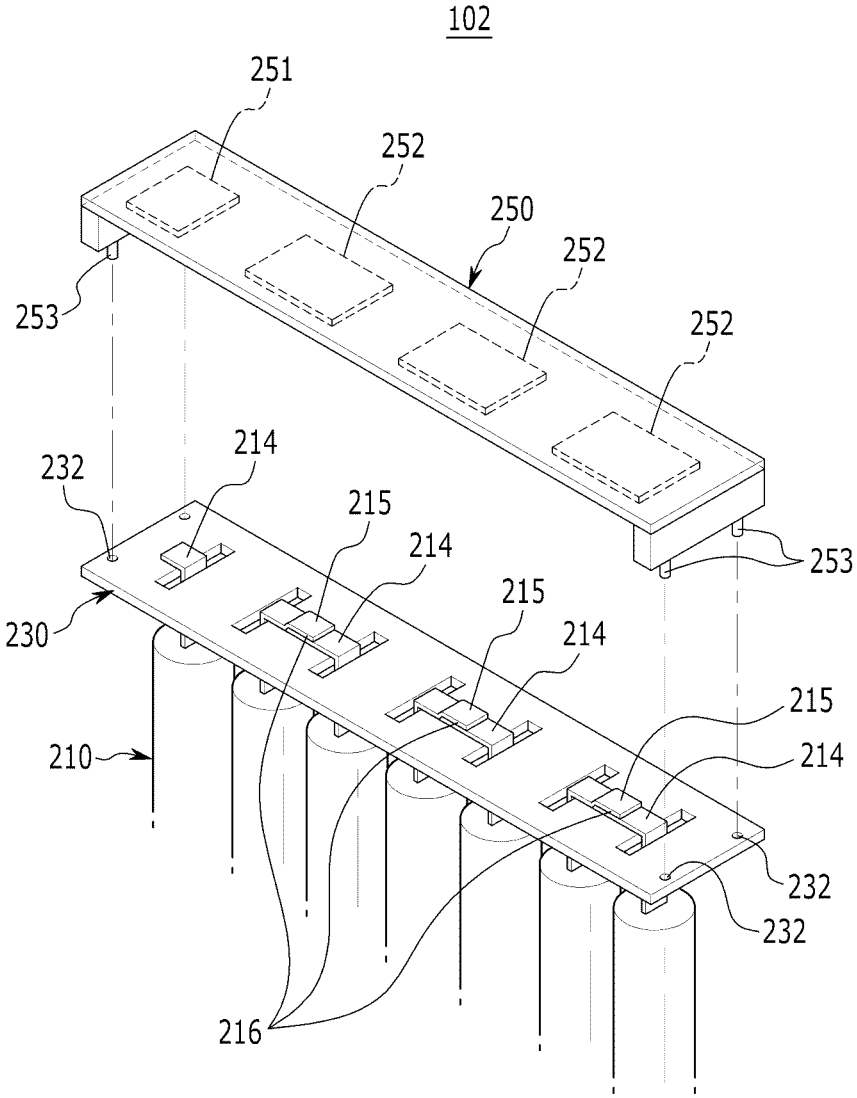
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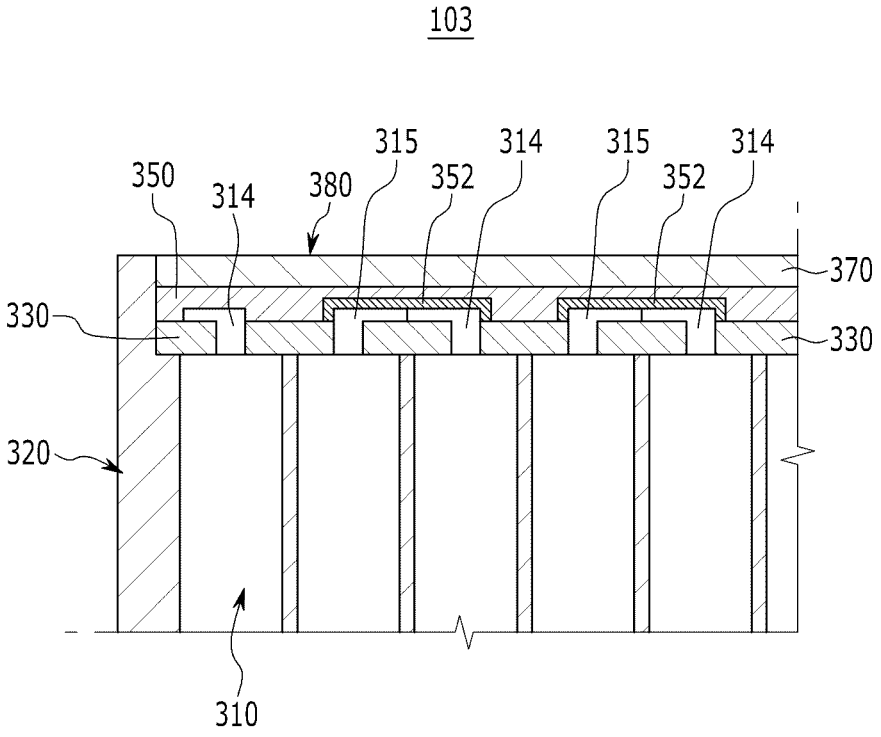
FIG. 8



RECHARGEABLE BATTERY WITH COLLECTOR PLATES HAVING INSULATORS AND CONDUCTORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and the benefit of Korean Patent Application No. 10-2011-0078814, filed in the Korean Intellectual Property Office on Aug. 8, 2011, the entire contents of which are incorporated herein by reference.

BACKGROUND

1. Field

Embodiments of the present disclosure relate generally to rechargeable batteries and, more particularly, to rechargeable batteries with high voltage and a large capacity.

2. Description of the Related Art

A rechargeable battery can be charged and discharged, unlike a primary battery. The rechargeable battery can repeatedly perform charge and discharge processes. In a charge process, electrical energy may be transformed into chemical energy and stored. In a discharge process, the stored chemical energy may be transformed into electrical energy.

Examples of rechargeable batteries may include nickel hydrogen batteries, nickel cadmium batteries, lithium ion batteries, lithium polymer batteries and so on. Rechargeable batteries having relatively low capacity may be used in small portable electronic devices, such as mobile phones, laptop computers, and camcorders. High capacity rechargeable batteries may be used to provide power for driving motors (e.g., motors of hybrid vehicles), storing electric power, and the like.

Particularly, hybrid vehicles and electric vehicles have been actively developed, so demands on the high-voltage rechargeable batteries and large-capacity rechargeable batteries have been recently increased.

Large electrode assemblies may be are manufactured so as to manufacture high-voltage rechargeable batteries and/or large-capacity rechargeable batteries. However, high-voltage rechargeable batteries and large-capacity rechargeable batteries commonly exhibit productivity deterioration compared to low-capacity rechargeable batteries because they are manufactured using a relatively complicated manufacturing process. Accordingly, development of high-voltage rechargeable batteries and large-capacity rechargeable batteries that can be configured with simple structures is desirable.

The above information disclosed in this Background section may be for enhancement of understanding of the background of the described technology and, therefore, it may contain information that does not form the prior art that may be already known to a person of ordinary skill in the art.

SUMMARY

The described technology has been made in an effort to provide a high-voltage rechargeable battery or a large-capacity rechargeable battery that can be configured with a simple structure.

An exemplary embodiment provides a rechargeable battery including: a plurality of electrode assemblies including a positive electrode, a negative electrode, and a separator provided between the positive electrode and the negative electrode, and a pair of electrode tabs protrude to both sides; a case for receiving the plurality of electrode assemblies; a first current collecting plate and a second current collecting plate for covering openings formed on both sides of the case; and a first insulation plate and a second insulation plate disposed between the plurality of electrode assemblies and the first current collecting plate and between the plurality of electrode assemblies and the second current collecting plate

Each of the pair of the electrode tabs passes through a first through hole and a second through hole formed in the first insulation plate and the second insulation plate and is bent so the plurality of electrode assemblies are fixed in the first insulation plate and the second insulation plate.

The electrode tab includes a positive tab connected to the positive electrode and a negative tab connected to the negative electrode, at least one positive tab is electrically connected to the first current collecting plate, and at least one negative tab is electrically connected to the second current collecting plate.

The plurality of electrode assemblies are received so that electrode tabs with different polarities may neighbor each other, and the neighboring positive tab and negative tab are electrically connected so the plurality of electrode assemblies are electrically connected in series.

The plurality of electrode assemblies are received so that electrode tabs with the same polarity may neighbor each other, and the positive tab is electrically connected to the neighboring positive tab and the negative tab is electrically connected to the neighboring negative tab so a plurality of electrode assemblies are electrically connected in parallel.

Electrode tabs of a pair of neighboring electrode assemblies from among the plurality of electrode assemblies are bent in opposite directions.

Neighboring electrode tabs that are bent in the opposite directions form an overlapped area where they are overlapped and connected.

An electrode tab having no overlapped area from among the electrode tabs is electrically connected to the first current collecting plate or the second current collecting plate.

The first current collecting plate and the second current collecting plate include a first insulator and a second insulator that are protruded inside the case, and the overlapped area contacts a first insulator of the first current collecting plate or a second insulator of the second current collecting plate.

The electrode tab includes a positive tab connected to the positive electrode and a negative tab connected to the negative electrode, the first current collecting plate and the second current collecting plate further include a first conductor and a second conductor that are protruded inside the case, at least one of the positive tabs contacts the first conductor, and at least one of the negative tabs contacts the second conductor.

The electrode tabs of the plurality of electrode assemblies are bent in the same direction.

A plurality of insertion holes into which the plurality of electrode assemblies are inserted are formed in the case.

Each of the plurality of insertion holes has the same surface form as the plurality of electrode assemblies.

The second insulation plate is integrally formed with the case.

The case is formed with an insulating material.

Each of the plurality of electrode assemblies is formed in a jellyroll shape in which the positive electrode, the negative electrode, and the separator are spirally wound.

The first insulation plate or the second insulation plate is fixed to the first current collecting plate or the second current collecting plate to be integrally formed.

A groove is formed on both edges of the first insulation plate, a protrusion is formed to be protruded in a direction facing the first insulation plate on both edges of the first current collecting plate, and the protrusion is combined with

the groove so the first insulation plate and the first current collecting plate are integrally fixed.

The first insulation plate is made of a polymer layer, the first current collecting plate is made of a metal layer, the metal layer and the polymer layer are adhered to each other to form a laminate, and a groove unit corresponding to the first through-hole of the first insulation plate is formed on the metal layer.

In another embodiment, method of making a rechargeable battery may be provided. The method may include providing a plurality of electrode assemblies that include a positive electrode, a negative electrode, and a separator provided between the positive electrode and the negative electrode. The method may further include a pair of electrode tabs that protrude from both sides of respective electrode assemblies of the plurality of electrode assemblies. The method may additionally include a case for receiving the plurality of electrode assemblies, where first and second openings are formed on first and second sides of the case. The method may also include a first current collecting plate and a second current collecting plate, where the first current collecting plate covers the first opening of the case and the second current collecting plate covers the second opening formed on the second side of the case. The method may further include a first insulation plate and a second insulation plate, where the first insulation plate includes a plurality of through holes and is disposed between the plurality of electrode assemblies and the first current collecting plate and where the second insulation plate includes a plurality of second through holes and is disposed between the plurality of electrode assemblies and the second current collecting plate

In a further embodiment, the first electrode tab of each of the pair of the electrode tabs may pass through a first through hole and a second electrode tab of each of the pair of the electrode tabs may pass through a second through hole formed in the second insulation plate. Each of the pair of electrode tabs may be bent so that the plurality of electrode assemblies are fixed in the first insulation plate and the second insulation plate.

In other embodiments, the pair of electrode tabs may include a positive tab connected to the positive electrode and a negative tab connected to the negative electrode. At least one positive tab of the plurality of electrode assemblies may be electrically connected to the first current collecting plate and at least one negative tab of the plurality of electrode assemblies may be electrically connected to the second current collecting plate.

In an embodiment, the plurality of electrode assemblies may be received in the case so that electrode tabs with different polarities may neighbor each other. Neighboring positive tabs and negative tabs may be electrically connected so that the plurality of electrode assemblies are electrically connected in series.

In additional embodiments, the plurality of electrode assemblies may be received in the case so that electrode tabs with the same polarity may neighbor each other. Neighboring positive tabs may be electrically connected to each other and neighboring negative tabs may be electrically connected to each other. So configured, the plurality of electrode assemblies are electrically connected in parallel.

In certain embodiments, electrode tabs of a pair of neighboring electrode assemblies from among the plurality of electrode assemblies are bent in opposite directions.

In selected embodiments, neighboring electrode tabs that are bent in the opposite directions form an overlapped area where they are overlapped and connected to each other.

In other embodiments, an electrode tab having no overlapped area from among the electrode tabs may be electrically connected to one of the first current collecting plate and the second current collecting plate.

In additional embodiments, the first current collecting plate may include a first insulator and the second current collecting plate may include a second insulator. The first and second insulators may protrude inside the case. The overlapped area may contact one of the first insulator of the first current collecting plate and the second insulator of the second current collecting plate.

In an embodiment, the pair of electrode tabs may include a positive tab connected to the positive electrode and a negative tab connected to the negative electrode. The first current collecting plate may include a first conductor and the second current collecting plate may include a second conductor. The first and second conductors may protrude inside the case. At least one of the positive tabs may contact the first conductor and at least one of the negative tabs may contact the second conductor.

In other embodiments, the electrode tabs of the plurality of electrode assemblies are bent in the same direction.

In further embodiments, the case may further comprise a plurality of insertion holes configured to receive the plurality of electrode assemblies.

In alternative embodiments, each of the plurality of insertion holes may have the same cross-sectional shape as the plurality of electrode assemblies.

In additional embodiments, the second insulation plate may be integrally formed with the case.

In an embodiment, the case may be formed with an insulating material.

In further embodiments, each of the plurality of electrode assemblies may be formed in a jellyroll shape in which the positive electrode, the negative electrode, and the separator are spirally wound.

In additional embodiments, the first insulation plate and the second insulation plate may be configured such that either the first insulation plate is fixed to the first current collecting plate or the second insulation plate is fixed to the second current collecting plate

In other embodiments, the first insulation plate may include a plurality of grooves formed on both edges. The first current collecting plate may include a plurality of protrusions formed on both edges in a direction facing the first insulation plate. At least a portion of the plurality of protrusions may be inserted into the plurality of grooves.

In alternative embodiments, the first insulation plate may comprise a polymer layer and the first current collecting plate may comprise a metal layer. A plurality of groove units corresponding to the plurality of first through holes of the first insulation plate may be formed on the metal layer. The metal layer and the polymer layer may be adhered to each other to form a laminate.

According to the embodiment, the high-voltage rechargeable battery or the large-capacity rechargeable battery is formed with a simple configuration to improve productivity of the rechargeable battery.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a cross-sectional view of a rechargeable battery according to a first embodiment;

FIG. **2** shows an exploded perspective view of a rechargeable battery according to a first embodiment;

FIG. **3** shows a perspective view of an electrode assembly of a rechargeable battery according to a first embodiment;

FIG. **4**A and FIG. **4**B show that electrode tabs of a rechargeable battery according to a first embodiment are connected;

FIG. **5** shows a perspective view of a connected state of electrode tabs of a rechargeable battery according to a first embodiment and a current collecting plate;

FIG. **6** shows a cross-sectional view of a rechargeable battery according to a second embodiment;

FIG. **7** shows a partial exploded perspective view of a rechargeable battery according to a third embodiment; and

FIG. **8** shows a partial cross-sectional view of a rechargeable battery according to a fourth embodiment.

DETAILED DESCRIPTION

Embodiments of the present disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown.

In order to clarify a description of the disclosed embodiments, parts not related to the description are omitted, and the same reference numbers are used throughout the drawings to refer to the same or like parts. In addition, the size and thickness of each component shown in the drawings are arbitrarily shown for understanding and ease of description, but the present invention may be not limited thereto.

The terms "coupled" or "connected" as used herein have their ordinary meaning as known to those skilled in the art and may include, but are not limited to, mechanical connections, electrical connections, and combinations thereof. For example, in certain embodiments, when it may be described that a first element may be "coupled" or "connected" to a second element, the first element may be directly coupled or directly connected to the second element or electrically coupled or electrically connected to the second element through a third element.

FIG. **1** shows a cross-sectional view of a rechargeable battery according to a first embodiment, and FIG. **2** shows an exploded perspective view of a rechargeable battery according to the first embodiment.

Referring to the embodiments of FIG. **1** and FIG. **2**, the rechargeable battery **100** may include a plurality of electrode assemblies **10** and a case **20** configured to receive the plurality of electrode assemblies **10**. The rechargeable battery **100** may further include current collecting plates **50** and **60**, which may be electrically connected to the plurality of electrode assemblies **10** and insulation plates **30** and **40**. The insulation plates **30** and **40** may be, respectively, disposed between the current collecting plates **50** and **60** and the plurality of electrode assemblies **10**.

In the embodiment of FIG. **1** and FIG. **2**, a jellyroll type of electrode assembly may be illustrated for the electrode assembly **10**.

FIG. **3** shows a perspective view of an electrode assembly **10** of the rechargeable battery **100** according to the first embodiment. The electrode assembly **10** according to the first embodiment will now be described with reference to FIG. **3**.

Referring to FIG. **3**, each electrode assembly within the plurality of electrode assemblies **10** may include a positive electrode **11**, a negative electrode **12**, and a separator **13** provided there between. An electrode assembly may be formed in a circular jellyroll shape by spirally winding the positive electrode **11** and the negative electrode **12**.

Each electrode assembly within the plurality of electrode assemblies **10** may further include electrode tabs **14** and **15** that protrude from opposite ends of each electrode assembly. The electrode tabs **14** and **15** may include a positive tab **14** that may be electrically connected to the positive electrode **11** and a negative tab **15** that may be electrically connected to the negative electrode **12**. In detail, the positive tab **14** and the negative tab **15** may be connected to a positive electrode uncoated region and a negative uncoated region respectively formed on the positive electrode **11** and the negative electrode **12**.

The separator **13** provides a short circuit between the positive electrode **11** and the negative electrode **12** and insulates the electrode assembly **10** from the outside. An insulating tape can also be attached to a part where the positive electrode **11** and the negative electrode **12** are exposed outside the electrode assembly **10** so as to prevent the short circuit from the outside.

It may be understood that embodiments of the present disclosure may be are not limited to the illustrated electrode assembly, and the electrode assembly can be formed as a jellyroll in various forms in addition to the circular shape.

With further reference to FIG. **1** and FIG. **2**, a plurality of insertion holes **21** into which the plurality of electrode assemblies **10** may be inserted may be formed inside the case **20**. Each insertion hole **21** can have the same cross-sectional shape as the plurality of electrode assemblies **10**. In this manner, the insertion holes **21** may be configured to receive the electrode assembly **10**. For example, in the first embodiment of FIGS. **1**, **2**, and **3**, circular jellyroll type of electrode assembly **10** may be used, the insertion holes **21** can be formed to be cylindrical hollows.

The case **20** can be formed with an electrically insulating material. For example, the case **20** can be formed with insulating resins including, but not limited to, polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET).

In the first embodiment, in order to electrically couple the plurality of electrode assemblies **10** in series, the polarities of the electrode tabs **14** and **15** of the neighboring electrode assemblies **10** may be differently disposed. For example, when the positive tab **14** and the negative tab **15** are formed on an upper part and a lower part of the electrode assembly **10**, respectively, the negative tab **15** and the positive tab **14** may also be formed on an upper part and a lower part of their neighboring electrode assembly **10**. In this manner, the positive tabs **14** and the negative tabs **15** are alternately disposed in the direction in which the electrode assembly **10** may be disposed. Therefore, the positive tab **14** and the negative tab **15** of electrode assemblies **10** neighboring each other may be electrically connected so that the plurality of electrode assemblies **10** are electrically connected in series.

Openings may be formed on both sides of the case **20** so as to receive the plurality of electrode assemblies **10** into the case **20**. The first current collecting plate **50** and the second current collecting plate **60** may, respectively, cover the openings **21** of the case **20** into which the electrode assemblies **10** are received.

The first current collecting plate **50** and the second current collecting plate **60** may close and seal the inside of the case **20**, and The first and second current collecting plates **50** and **60** may also be electrically connected to the positive electrode **11** and the negative electrode **12** of the electrode assembly **10**, respectively, to function as a positive terminal and a negative terminal for connecting a current generated by the electrode assembly **10** to an external device. In certain embodiments, for this purpose, the first current collecting plate **50** and the second current collecting plate **60** can be made of a metal such as aluminum or copper.

A first conductor **51** and a first insulator **52** that protrude inside the case **20** may be formed in the first current collecting plate **50**. A second conductor **61** and a second insulator **62** that

protrude inside the case **20** may be formed in the second current collecting plate **60**. As a result, the positive electrode **11** may be electrically connected to the first current collecting plate **50** through contact of the first conductor **51** and the positive tab **14**, and the negative electrode **12** may be electrically connected to the second current collecting plate **60** through contact of the second conductor **61** and the negative tab **15**. A detailed description of the connection state between the electrode tabs **14** and **15** and the current collecting plates **50** and **60** may be described later below.

The first current collecting plate **50** may be connected to the positive electrode **11** and the second current collecting plate **60** may be connected to the negative electrode **12** in the present exemplary embodiment. In alternative embodiments, the first current collecting plate **50** can be connected to the negative electrode **12** and the second current collecting plate **60** can be connected to the positive electrode **11**.

The first insulation plate **30** may be disposed between the first current collecting plate **50** and the plurality of electrode assemblies **10**. The second insulation plate **40** may be disposed between the second current collecting plate **60** and the plurality of electrode assemblies **10**.

A first through hole **31** and a second through hole **41** may be formed in the first insulation plate **30** and the second insulation plate **40** so that the electrode tabs **14** and **15** of the electrode assembly **10** that are received into the case **20** may be connected to the outside. The electrode tabs **14** and **15** of the electrode assembly **10** may also be bent after penetrating the through holes **31** and **41** of the insulation plates **30** and **40**.

The electrode assembly **10** can be fixed to the insulation plates **30** and **40** according to embodiments of the above-noted configuration, and the neighboring electrode assembly **10** can be connected without an additional bonding process between the electrode tabs **14** and **15**, as described in greater detail below.

The through holes **31** and **41** of the insulation plates **30** and **40** may allow the electrode tabs **14** and **15** to pass there through and fix the electrode assembly **10**. The shape and the size of the through holes **31** and **41** may also be controlled so they can function as electrolyte injection openings for injecting an electrolyte solution into the case **20** in which the electrode assembly **10** is received. Accordingly, there may be no need to form an additional electrolyte injection opening in the rechargeable battery **100**.

In certain embodiments, the first insulation plate **30** and the second insulation plate **40** can be formed with the same insulation material as the case **20**.

The first insulation plate **30** may be independently formed from the case **20** so it can be bonded with the inner part of the case **20** when the electrode assembly **10** is received into the case **20**. In detail, the first insulation plate **30** and the case **20** can be bonded together by applying an adhesive at about the point of contact between the first insulation plate **30** and the case **20** after disposing the first insulation plate **30**. In addition, the first insulation plate **30** and the case **20** can be bonded by forming a groove in the case **20**, forming a protrusion in the first insulation plate **30**, and thus inserting the protrusion of the first insulation plate **30** into the groove of the case **20**.

In certain embodiments, the second insulation plate **40** can be integrally formed with the case **20**. The electrode assembly **10** can be received into one side of the case **20** in which the first insulation plate **30** is disposed so that the second insulation plate **40** can be integrally formed while the case **20** is formed. Accordingly, the process for manufacturing embodiments of the rechargeable battery **100** can be simplified by not forming the second insulation plate **40** and bonding it to the case **20** in the same manner as the first insulation plate **40**. However, in alternative embodiments, depending on the process, it may be possible to separately form the second insulation plate **40** and bond it to the case **20** in a like manner of the first insulation plate **30**.

The first current collecting plate **50** and the second current collecting plate **60** can be combined with the case **20** so as to cover the opening of the case **20** when the electrode assembly **10** may be received and the first insulation plate **30** may be bonded to the case **20**. In this instance, the combination of the first and second current collecting plates **50** and **60** with the case **20** can also be performed by using the adhesive as described above for the first insulation plate **30** or by mechanical combination as described above for the second insulation plate **40**.

In certain embodiments, the electrolyte solution is injected into the case **20** while the current collecting plates **50** and **60** are bonded to the case **20**. Accordingly, the second current collecting plate **60** may be bonded to the case **20**, the electrolyte solution may be injected into the case **20**, and the first current collecting plate **50** may be bonded to the case **20**.

Hereinafter, referring to FIG. **4**A to FIG. **5**, a connection structure of an electrode tab and a current collecting plate of a rechargeable battery according to the first embodiment of the rechargeable battery **100** will be described in detail.

FIG. **4**A and FIG. **4**B show electrode tabs **14** and **15** of the rechargeable battery **100** according to the first embodiment in a connected state. These electrode tabs **14** and **15** may be connected with respect to an upper part of the first insulation plate **30** (FIG. **4**A) and a lower part of the second insulation plate (FIG. **4**B). FIG. **5** shows a perspective view the electrode tabs **14** and **15** of the rechargeable battery **100** in a connected state of according to a first exemplary embodiment and the current collecting plate **50**.

Referring to FIG. **4**A and FIG. **4**B, the electrode tabs **14** and **15** of the electrode assembly **10** are passed through the first through hole **31** and the second through hole **41** so as to protrude outside the first insulation plate **30** and the second insulation plate **40**. The protruding portions of the electrode tabs **14** and **15** may be bent.

With further reference to FIG. **4**A and FIG. **4**B, the six electrode tabs **14** and **15** on the right side of respective pairs of electrode assemblies **10**, from the viewpoint of an upper part of the case **20**, may be bent towards the center of their respective electrode assembly **10** pair. In this manner, the positive tab **14** and the negative tab **15** may be overlapped to form an overlapped area. Similarly, the six electrode tabs **14** and **15** on the left side of respective pairs of electrode assemblies **10**, from the viewpoint of a lower part of the case **20**, may also be bent towards the center of their respective electrode assembly **10** pair. In this manner, the positive tab **14** and the negative tab **15** may also be overlapped to form an overlapped area.

In certain embodiments, the directions that neighboring electrode tabs **14** and **15** are bent may be opposite to each other. Also, the directions which the positive tab **14** and the negative tab **15** in a single electrode assembly are bent may be opposite to each other.

FIG. **5** shows a connected state of the electrode tabs **14** and **15** and the current collecting plate **50** from the viewpoint of the upper part of the case **20**. Given the correspondence between this configuration and that of the electrode tabs **14** and **15** and the current collecting plate **60** in the connected state at the lower part of the case **20**, the connected state at the lower part of the case **20** will only be briefly described.

Referring to FIG. **5**, the electrode tabs **14** and **15** are inserted into the first through hole **31** of the first insulation plate **30** and are then bent. The electrode tabs **14** and **15** of neighboring electrode assemblies **10** are bent in opposite

directions so that the positive tab **14** and the negative tab **15** are formed to be a pair and overlapped to form an overlapped area **16**. The negative tab **15** may be overlapped on the positive tab **14** in the first embodiment of the rechargeable battery **10**. Alternatively, it may be sufficient for the neighboring electrode tabs **14** and **15** to be overlapped to contact each other so the positive tab **14** can be overlapped on the negative tab **15**.

When the positive tab **14** and the negative tab **15** are formed to be a pair to form the overlapped area **16** as described, the first current collecting plate **50** may be combined with the opening of the case and may be disposed on the upper part of the first insulation plate **30**.

A first conductor **51** and one or more first insulators **52** may protrude toward the inside of the case **20** may be formed in the first current collecting plate **50**. The first conductor **51** may be formed corresponding to a position of the positive tab **14** that is not part of a pair of electrode assemblies **10** (e.g., at about an end of the rechargeable battery **100**. The first insulator **52** may be formed corresponding to a position where respective positive tabs **14** and the negative tabs **15** are paired and form a plurality of overlapped areas **16**.

Accordingly, the first current collecting plate **50** may be combined with the opening of the case **20** and the first conductor **51** may contact the positive tab **14** to electrically connect the first current collecting plate **50** to the positive electrode of the electrode assembly **10**. The first insulators **52** may inhibit the neighboring positive tabs **14** and negative tabs **15** forming the respective connected overlapped areas **16** from contacting the first current collecting plate **50** and generating a short circuit. Further, the plurality of first insulators **52** may exert pressure upon the overlapped areas **16** while the first current collecting plate **50** is combined with the opening of the case **20** to inhibit the neighboring pairs of positive tabs **14** and the negative tabs **15** forming the overlapped areas **16** from becoming disconnected from one another.

A combination between the electrode tabs **14** and **15** and the second current collecting plate **60** may be performed in a like manner. That may be, the second current collecting plate **60** may include a second conductor **61** and a plurality of second insulators **62** formed inside the case **20**, as illustrated in FIG. **3**. The second current collecting plate **60** may be combined to the opening in the lower portion of the case **60** and the second conductor **60** may contact the negative tab **15** that is not part of a pair of electrode assemblies **10**. The plurality of second insulators **62** may inhibit the neighboring positive tabs **14** and negative tabs **15** forming the respective connected overlapped areas from contacting the contacting the second current collecting plate **60** and generating a short circuit. The plurality of second insulators **62** may exert pressure upon the overlapped areas while the second current collecting plate **60** may be combined with the opening of the case **20** to control the disconnection of the neighboring positive tab **14** and the negative tab **15**.

By connecting neighboring electrode assemblies **10**, a plurality of electrode assemblies **10** can be coupled in series to form the high-voltage rechargeable battery **100**.

Also, while the electrode assemblies **10** are coupled in series, the processes for bonding the electrode tabs **14** and **15** together, such as welding may be reduced or substantially omitted from the process for manufacturing embodiments of the rechargeable battery **100**. In this manner, the process for manufacturing the high voltage rechargeable battery **100** may be simplified and the productivity of the rechargeable battery **100** may be improved.

In the above discussed embodiment of the rechargeable battery **100**, the rechargeable battery **100** is indicated as including seven electrode assemblies **10**. However, it may be understood that the number of the electrode assemblies **100** included in embodiments of the rechargeable battery **100** may be varied, as necessary. For example, the number of electrode assemblies **10** may be selected so as to provide an output voltage appropriate for usage or purpose of the rechargeable battery **100**.

FIG. **6** shows a cross-sectional view of a rechargeable battery **101** according to a second embodiment. A configuration of the rechargeable battery **101** according to the second embodiment will now be described with reference to FIG. **3**. As described in greater detail below, the second embodiment of the rechargeable battery **101** modifies the configuration of the electrode assemblies **10** with respect to the first embodiment of the rechargeable battery **100** so that the electrode assemblies **10** are configured in parallel. In the discussing the second embodiment of the rechargeable battery **101**, elements having the same or similar configurations as found in the first embodiment of the rechargeable battery **100** will be briefly described or omitted.

The rechargeable battery **101** may include a plurality of electrode assemblies **10** and a case **20**. Also, the rechargeable battery **101** may include current collecting plates **150** and **160**. The current collecting plates **150** and **160** may be electrically connected to the electrode assembly **10** and insulation plates **30** and **40**. The insulation plates **30** and **40** may be disposed between the current collecting plates **150** and **160** and the electrode assembly **10**.

The electrode assemblies **10** may be formed in a jellyroll shape and may be received in a plurality of corresponding insertion holes **21** formed inside the case **20**.

In order to couple a plurality of the electrode assemblies **10** in parallel to form the second embodiment of the rechargeable battery **101**, the electrode assemblies **10** may be received and disposed so that electrode tabs **14** and **15** with the same polarity neighbor each other. For example, referring to FIG. **6**, the positive tabs **14** of respective electrode assemblies **10** may be disposed on an upper side of the case **20** and the negative tabs **15** of the respective electrode assemblies **10** may be disposed on a lower side of the case **20**. Therefore, the positive tabs **14** of neighboring electrode assemblies **10** may be electrically connected to one another. Similarly, the negative tabs **15** of neighboring electrode assemblies **10** may be electrically connected to one another. In this manner, the plurality of electrode assemblies **10** may be electrically connected in parallel.

The insulation plates **30** and **40** may be disposed to cover both sides of the electrode assembly **10**. The positive tabs **14** of the electrode assembly **10** may be passed through the first plurality of through holes **31** of the first insulation plate **30** to protrude to an upper side of the case **20** and be bent. Likewise, the negative tabs **15** of the electrode assembly **10** may be passed through the second plurality of through holes **41** of the second insulation plate **40** to protrude to a lower side of the case **20** and be bent.

In the second embodiment of the rechargeable battery **101**, the bending directions of the electrode tabs **14** and **15** are set to be the same and the neighboring electrode tabs **14** and **15** are not overlapped. However, it may be possible to overlap the neighboring electrode tabs **14** and **15** and form an overlapped area in a like manner of the first exemplary embodiment.

The first current collecting plate **150** and the second current collecting plate **160** may be combined with the case **20** to cover the openings that are respectively formed on the upper side and the lower side of the case **20**. The first and second current collecting plates **150** and **160** may contact the positive

tab **14** and the negative tab **15** that are passed through the first insulation plate **30** and the second insulation plate **40** and are bent.

Accordingly, the first current collecting plate **150** may be electrically connected to the positive electrode **11** of the electrode assembly **10**, and the second current collecting plate **160** may be electrically connected to the negative electrode **12** of the electrode assembly **10**. So configured, the first and second current collecting plates **150** and **160** may respectively function as a positive electrode terminal and a negative terminal.

Further, the first current collecting plate **150** and the second current collecting plate **160**, when combined with the opening of the case **20**, exert pressure on the positive tabs **14** and the negatives tab **15** to inhibit disconnection between the electrode assembly **10** and the current collecting plates **150** and **160**.

The large-capacity rechargeable battery **101** may be formed by connecting the electrode assemblies **10** in parallel in the present embodiment.

Further, when the electrode assemblies **10** are coupled in parallel, additional bonding process, such as welding may be, reduced or substantially omitted from the process for manufacturing the second embodiment of the rechargeable battery **101**. In this manner, the process for manufacturing the large-capacity rechargeable battery **101** may be simplified and the productivity of the rechargeable battery **101** may be improved.

The above-described embodiments have illustrated rechargeable battery configurations in which the first insulation plate **30** or the second insulation plate **40** is formed to be separated from the first current collecting plate **50** or the second current collecting plate **60**. In alternative embodiments, the first insulation plate **30** can be fixed to or integrally formed with the first current collecting plate or the second insulation plate **40** can be respectively fixed to or integrally formed with the first current collecting plate **50** and the second current collecting plate **60**.

A third embodiment of the rechargeable battery **102** in which a current collecting plate and an insulation plate are integrally formed will now be described with reference to FIG. **7** and FIG. **8**.

FIG. **7** shows a partial exploded perspective view of the rechargeable battery **102** according to the third exemplary embodiment. In describing the third embodiment of the rechargeable batter **102**, components and configurations that are the same or similar to the first embodiment of the rechargeable battery **100** will be briefly described or omitted.

The rechargeable battery **102** may include a plurality of electrode assemblies **210** and a case (not shown) for receiving the electrode assemblies **210**. Also, the rechargeable battery **102** may include a first current collecting plate **250** electrically connected to the electrode assembly **210** and a first insulation plate **230** disposed between the first current collecting plate **250** and the electrode assembly **210**. A first conductor **251** and a first insulator **252** that protrude inside the case can be formed in the first current collecting plate **250**.

In order to couple a plurality of electrode assemblies **210** in series in the present embodiment, the polarities of the electrode tabs **214** and **215** of the neighboring electrode assemblies **210** may be disposed to be different. That is, when a positive tab **214** and a negative tab **215** are formed on the upper part and the lower part of one of the electrode assemblies **210**, a negative tab **215** and a positive tab **214** are formed on the upper part and the lower part of a neighboring the electrode assembly **210**. As such, the positive tabs **214** and the negative tabs **215** are alternately disposed in the direction in which the electrode assembly **210** is disposed. Therefore, the neighboring positive tabs **214** and negative tabs **215** may be electrically connected so a plurality of electrode assemblies **210** can be electrically connected in series. In the embodiment of FIG. **7**, the positive tabs **214** and the negative tabs **215** of neighboring electrode assemblies **210** may be overlapped to form overlapped areas **216**.

A plurality of protrusions **253** may be formed on both edges of the first current collecting plate **250** in the in a direction facing the first insulation plate **230**. A plurality of grooves **232** may also be formed on both edges of the first insulation plate **230** so the protrusions **253** may be fixed to the grooves **232** (e.g., the protrusions **253** may be inserted in the grooves **232**). In this manner, the first current collecting plate **250** and the first insulation plate **230** can be integrally formed.

FIG. **8** shows a partial cross-sectional view of a rechargeable battery **103** according to a fourth embodiment. As described in greater detail below, the fourth embodiment of the rechargeable battery **103** illustrates an alternative configuration for integrally forming the current collecting plate and the insulation plate. In describing the fourth embodiment of the rechargeable battery **103**, components and configurations that are the same or similar to the first exemplary embodiment will be briefly described or omitted.

The rechargeable battery **103** may include a plurality of electrode assemblies **310** and a case **320** for receiving the electrode assemblies **310**. A current collecting plate and the insulation plate can be fixed with a laminate **380** and can be integrally formed.

The laminate **380** may be configured with a metal layer **350** (i.e., a current collecting plate) and a first polymer layer **370** and a second polymer layer **330** (i.e., an insulation plate) bonded on both surfaces of the metal layer **350**. The metal layer **350** can be made of metals including, but not limited to, aluminum, stainless steel, and clad metal bonded with aluminum and copper. In this manner, the metal layer **350** can function as a current collecting plate and the second polymer layer **330** can function as an insulation plate.

A plurality of groove units may be formed on the lower part of the metal layer **350** and the first insulator **352** may be bonded to the inside of the groove units. The first insulator **352** may be formed to have the groove shape and receive the positive tabs **314** and the negative tabs **315**. A plurality of through-holes may be formed in the second polymer layer **330** to allow the positive tabs **314** and the negative tabs **315** to penetrate the through-holes.

The above-noted laminate **380** can be manufactured by using injection molding processes and can be respectively formed on the upper part and the lower part of the electrode assembly **310**.

Although the foregoing description has shown, described, and pointed out the fundamental novel features of the present teachings, it will be understood that various omissions, substitutions, changes, and/or additions in the form of the detail of the apparatus as illustrated, as well as the uses thereof, may be made by those skilled in the art, without departing from the scope of the present teachings. Consequently, the scope of the present teachings should not be limited to the foregoing discussion, but should be defined by the appended claims.

What is claimed is:

1. A rechargeable battery comprising:

a plurality of electrode assemblies including

a positive electrode,

a negative electrode, and

a separator provided between the positive electrode and the negative electrode, and

a pair of electrode tabs protrude to both sides wherein the pair of electrode tabs comprises a positive electrode tab connected to the positive electrode and a negative electrode tab connected to the negative electrode;

a case for receiving the plurality of electrode assemblies;

a first current collecting plate which comprises a positive current collecting plate and a second current collecting plate which comprises a negative current collecting plate formed on both sides of the case, wherein the first current collecting plate and the second current collecting plate include a first insulator and a second insulator that are protruded inside the case, and a first conductor and a second conductor that are protruded inside the case; and

a first insulation plate and a second insulation plate disposed between the plurality of electrode assemblies and the first current collecting plate and between the plurality of electrode assemblies and the second current collecting plate, wherein

each of the pair of the electrode tabs passes through a first through hole and a second through hole formed in the first insulation plate and the second insulation plate, and

wherein electrode tabs of a pair of neighboring electrode assemblies from among the plurality of electrode assemblies are bent in opposite directions to form an overlapped area where they are overlapped and connected, the overlapped area contacting the first insulator of the first current collecting plate or the second insulator of the second current collecting plate, and

wherein at least one of the positive electrode tabs contacts the first conductor, and at least one of the negative electrode tabs contacts the second conductor.

2. The rechargeable battery of claim **1**, wherein

the each of the pair of the electrode tabs is bent so the plurality of electrode assemblies are fixed in the first insulation plate and the second insulation plate.

3. The rechargeable battery of claim **1**, wherein

the plurality of electrode assemblies are received so that electrode tabs with different polarities may neighbor each other, and

the neighboring positive tab and negative tab are electrically connected so the plurality of electrode assemblies are electrically connected in series.

4. The rechargeable battery of claim **1**, wherein

the plurality of electrode assemblies are received so that electrode tabs with the same polarity may neighbor each other, and

the positive tab is electrically connected to the neighboring positive tab and the negative tab is electrically connected to the neighboring negative tab so a plurality of electrode assemblies are electrically connected in parallel.

5. The rechargeable battery of claim **1**, wherein an electrode tab having no overlapped area from among the electrode tabs is electrically connected to the first current collecting plate or the second current collecting plate.

6. The rechargeable battery of claim **1**, wherein a plurality of insertion holes into which the plurality of electrode assemblies are inserted are formed in the case.

7. The rechargeable battery of claim **6**, wherein each of the plurality of insertion holes has the same surface form as the plurality of electrode assemblies.

8. The rechargeable battery of claim **1**, wherein the second insulation plate is integrally formed with the case.

9. The rechargeable battery of claim **1**, wherein the case is formed with an insulating material.

10. The rechargeable battery of claim **1**, wherein each of the plurality of electrode assemblies is formed in a jellyroll shape in which the positive electrode, the negative electrode, and the separator are spirally wound.

11. The rechargeable battery of claim **1**, wherein the first insulation plate or the second insulation plate is fixed to the first current collecting plate or the second current collecting plate to be integrally formed.

12. The rechargeable battery of claim **11**, wherein

a groove is formed on both edges of the first insulation plate,

a protrusion is formed to be protruded in a direction facing the first insulation plate on both edges of the first current collecting plate, and

the protrusion is combined with the groove so the first insulation plate and the first current collecting plate are integrally fixed.

13. The rechargeable battery of claim **11**, wherein

the first insulation plate is made of a polymer layer,

the first current collecting plate is made of a metal layer,

the metal layer and the polymer layer are adhered to each other to form a laminate, and a groove unit corresponding to the first through-hole of the first insulation plate is formed on the metal layer.

14. A method of fabricating a rechargeable battery, the method comprising:

providing a plurality of electrode assemblies, comprising a positive electrode, a negative electrode, a separator positioned between the positive and negative electrodes, and a pair of electrode tabs that protrude from both sides of respective electrode assemblies of the plurality of electrode assemblies, the pair of electrode tabs including positive tab connected to the positive electrode and a negative tab connected to the negative electrode;

positioning the plurality of electrode assemblies within a case configured to receive the plurality of electrode assemblies, wherein the case includes a first opening at a first end and a second opening at a second end;

covering the first opening of the case with a first current collecting plate which comprises a positive current collecting plate wherein the first collecting plate is in electrical communication with the positive electrode and includes a first insulator and a first conductor;

covering the second opening of the case with a second current collecting plate which comprises a negative current collecting plate wherein the second collecting plate is in electrical communication with the negative electrode and includes a second insulator and a second conductor, such that the first and second insulators protrude inside the case, the the first and second conductors protrude inside the case;

positioning a first insulation plate comprising a plurality of first through holes between the plurality of electrode assemblies and the first current collecting plate;

positioning a second insulation plate comprising a plurality of second through holes between the plurality of electrode assemblies and the second current collecting plate;

inserting a first electrode tab of each of the pair of the electrode tabs through the first plurality of through holes formed in the first insulation plate and a second electrode tab of each of the pair of the electrode tabs passes through the second plurality of through holes formed in the second insulation plate; and

bending each of the pair of electrode tabs so the plurality of electrode assemblies are fixed in the first insulation plate and the second insulation plate, wherein electrode tabs of a pair of neighboring electrode assemblies from among the plurality of electrode assemblies are bent in

opposite directions to form an overlapped area where they are overlapped and connected to each other, and

wherein the overlapped area contacts one of the first insulator of the first current collecting plate and the second insulator of the second current collecting plate, and at least one of the positive tabs contacts the first conductor, and at least one of the negative tabs contacts the second conductor.

15. The method of claim **14**, wherein:

the plurality of electrode assemblies are received in the case so that electrode tabs with different polarities neighbor each other, and

neighboring positive tabs and negative tabs are electrically connected so the plurality of electrode assemblies are electrically connected in series.

16. The method of claim **14**, wherein:

the plurality of electrode assemblies are received in the case so that electrode tabs with the same polarity neighbor each other, and

neighboring positive tabs are electrically connected to each other and the neighboring negative tabs are electrically connected to each other so that the plurality of electrode assemblies are electrically connected in parallel.

17. The method of claim **14**, wherein an electrode tab having no overlapped area from among the electrode tabs is electrically connected to one of the first current collecting plate and the second current collecting plate.

18. The method of claim **14**, wherein the case further comprises a plurality of insertion holes configured to receive the plurality of electrode assemblies.

19. The method of claim **18**, wherein each of the plurality of insertion holes has the same cross-sectional shape as the plurality of electrode assemblies.

20. The method of claim **14**, wherein the second insulation plate is integrally formed with the case.

21. The method of claim **14**, wherein the case is formed from an insulating material.

22. The method of claim **14**, wherein each of the plurality of electrode assemblies is formed in a jellyroll shape in which the positive electrode, the negative electrode, and the separator are spirally wound.

23. The method of claim **14**, wherein the first insulation plate and the second insulation plate are configured such that either the first insulation plate is fixed to the first current collecting plate or the second insulation plate is fixed to the second current collecting plate.

24. The method of claim **23**, wherein:

the first insulation plate includes a plurality of grooves formed on both edges,

the first current collecting plate includes a plurality of protrusions formed on both edges and oriented in a direction facing the first insulation plate, and

at least a portion of the plurality of protrusions is inserted into the plurality of grooves.

25. The method of claim **23**, wherein:

the first insulation plate comprises a polymer layer,

the first current collecting plate comprises a metal layer, a plurality of groove units corresponding to the plurality of first through holes of the first insulation plate are formed on the metal layer, and

the metal layer and the polymer layer are adhered to each other to form a laminate.

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